Uniform difference schemes

$\varrho(h) \to 0$ when $h \to 0$), where $\tilde{y}_i$ is the solution of the difference boundary value problem with disturbed coefficients $\tilde{A}_i^h$, $\tilde{B}_i^h$, $\tilde{D}_i^h$, $\tilde{F}_i^h$, and $u(x)$ is the solution of problem (1). Its conservativeness is a necessary and sufficient condition for the coefficient stability of the canonical scheme. Questions relating to the convergence and accuracy of the conservative difference schemes are studied in §5. It is demonstrated that the zero-rank conservative scheme converges in the class of piecewise continuous coefficients ($k, q, f \in Q^{(0)}$); any conservative scheme of the first rank has the first order of accuracy in the class of coefficients $Q^{(m)}$ $(m \geqslant 1)$; any conservative scheme of the second rank which satisfies the conditions of the second order of approximation has the second order of accuracy in class $C^{(2)}$, but in class $Q^{(m)}$ $(m \geqslant 1)$ the first. These theorems are proved by means of an a priori estimate $\|z\|_1 \leqslant M\|\varphi\|_2$, where z is the error in the solution of the difference boundary value problem, and φ is the error in approximation of the scheme $L_h^{(k,q,f)}$ in the solution

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of problem (1). By estimating the error of approximation φ from the norm $\| \|_2$ it is possible to reduce the rank of the master functionals and the order m of the classes $C^{(m)}$ or $Q^{(m)}$ of the coefficients of equation (1). [Abstracter's note: Complete translation.]

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AUTHORS: Samarskiy, A. A., and Arsenin, V. Ya.

TITLE: On numerical solutions of gas-dynamic equations with various types of viscosity

PERIODICAL: Referativnyy zhurnal, Mekhanika, no. 12, 1961, 17, abstract 12B92 (Zh. vychisl. matem. i matem. fiz., 1961, 1, no. 2, 357-360)

TEXT: Finite-difference schemes of continuous calculation (in which lines of discontinuity do not appear) are considered for the equations of gas-dynamics of a plane, one-dimensional isentropic gas flow with various types of viscosity. Viscosity is subject to the following conditions: The system of equations should have a continuous solution, influence of viscosity should be vanishingly small within the shock layer, and, in the region of rarefaction wave, gyugonio [Abstracter's note: Transliteration] conditions should be fulfilled on the boundary of the layer

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representing a dispersed shock-wave. A rectangular space-time net is chosen to formulate difference equations. A difference scheme of "cross" type is utilized. The problem of the motion of a standing shock-wave is solved, and the solution of difference equations is written interms of moving waves. Problems on a standing shock-wave, its dispersion, etc., were calculated according to a "cross" scheme, with linear viscosity and Neumann viscosity. For linear viscosity, it was found possible to perform calculations with the time jump 3 - 4 times larger than for the Neumann viscosity. On the other hand, Neumann viscosity guarantees a smaller effective width of the shock layer. Comparison of numerical solutions with exact ones gave fair results for the linear viscosity case. [Abstracter's note: Complete translation.]

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TIKHONOV, A.N. (Moskva); SAMARSKIY, A.A. (Moskva)

Uniform difference systems of a high order of accuracy on nonuniform nets. Zhur. vych. mat. i mat. fiz. 1 no.3:425-440 My-Je '61. (MIRA 14:8)

(Difference equations)

S/044/62/000/006/079/127
B168/B112

16.3900

AUTHOR: Samarskiy, A. A.

TITLE: A priori estimates for the solution of the difference analog of a differential equation of parabolic type

PERIODICAL: Referativnyy zhurnal. Matematika, no. 6, 1962, 29, abstract 6V142 (Zh. vychisl. matem. i matem. fiz., v. 1, no. 3, 1961, 441-460)

TEXT: In an investigation into the convergence of difference schemes in the class of smooth coefficients, asymptotic orders of approximation and of accuracy usually coincide, which is generally not the case with discontinuous coefficients. In this last case, in a study of convergence the application of the maximum principle is excluded and the question of estimates of a different nature arises. An a priori estimate in a published work (RZhMat, 1960, 10932) is obtained on the assumption of "differentiability" with regard to x of the difference analog of the coefficient of heat conductivity. Examining the difference boundary value problem with boundary conditions of a more general type the author derives an analogous

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a priori estimate which is free from this limitation. The a priori estimates obtained from the author's integral formula assume that only the grid functions - the coefficients of the equation - are bounded. New a priori estimates are an effective means of proving the convergence and of estimating the accuracy of the difference schemes in the class of discontinuous coefficients. [Abstracter's note: Complete translation.]

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16.3900 16.6500

AUTHORS: Tikhonov, A. N., Samarskiy, A. A. (Moscow)

TITLE: The Sturm-Liouville finite difference problem

PERIODICAL: Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki, v. 1, no. 5, 1961, 784 - 805

TEXT: This is a continuation of the work on homogeneous difference schemes reported by the authors in the same journal (v. 1, no. 1, 1961, 5 - 63). The solution of the Sturm-Liouville problem for the equation

$$L^{(k,q)}u + \lambda r(x)u = 0,\ 0 < x < 1,\quad L^{(k,q)}u = \frac{d}{dx}\left[k(x)\frac{du}{dx}\right] - q(x)u(x) \qquad (1)$$

by the method of finite differences has been treated by a number of authors. They treated problems of precision and convergence in the class of smooth coefficients for difference schemes of the partial type. Subject work treats difference schemes studied in the above contribution, for the solution of the Sturm-Liouville problem in the class of discontinuous coefficients $Q^{(m)}$. The formulation of the problem, the characteristics of the original family of difference schemes, and the proof of

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The Sturm-Liouville finite difference problem

the convergence of the finite difference method are presented. With the aid of an a-priori estimate the order of precision for $Q^{(m,1)}$ for the solution of the finite difference problem at $h \to 0$ is established. It is proved that the difference scheme

$$L_h^{(k,q,\lambda r)} y = (a y_{\bar{x}})_x - dy + \lambda \rho y,$$

where

$$a = \left[\int_{-1}^{0} \frac{ds}{k(x+sh)} \right]^{-1}, \quad d = \int_{-0.5}^{0.5} q(x+sh)ds, \quad \rho = \int_{-0.5}^{0.5} r(x+sh)ds,$$

ensures precision of the second order for the class of discontinuous coefficients. In the continuations to follow the authors promise to treat homogeneous finite difference schemes yielding arbitrary orders of precision in the class of piece-by-piece continuous coefficients of equation (1), as well as the problem of precision on non-uniform grids. There are 5 references: 2 Soviet-bloc and 3 non-Soviet-bloc.

SUBMITTED: May 14, 1961

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16.3900 16.6500 16.3500

AUTHORS: Samarskiy, A. A., Fryazinov, I. V. (Moscow)

TITLE: On the convergence of homogeneous difference schemes for the heat-conduction equation with discontinuous coefficients

PERIODICAL: Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki, v. 1, no. 5, 1961, 806 - 824

TEXT: Considerable literature is devoted to difference methods for solving equations of the parabolic type. A great number of the contributions refers to equations with constant coefficients. The stability and convergence of schemes with continuous, sufficiently smooth coefficients have been studied before by others. The case of discontinuous coefficients leads to considerable difficulties since, as a rule, in the neighbourhood of a discontinuity the difference scheme does not approximate a differential operator. These difficulties may be overcome for the heat conduction equation only with the aid of special a-priori estimates. In earlier contributions (1959, 1960, 1961) Samarskiy introduced the notion of homogeneous difference schemes having one and the same computational algorithm at all the points of the difference grid for all the coefficients of the differential

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equation for some class of functions. In the present work he considers homogeneous schemes of the skew type for the solution of linear equations of the parabolic type with discontinuous coefficients without an explicit distinguishing of the lines of discontinuity, i.e. without any modification of the scheme in the neighbourhood of the line of discontinuity for the coefficients. Hence, most attention is paid to the problem of convergence of skew schemes in the class of discontinuous coefficients. For a quasilinear equation this problem was studied earlier by Samarskiy. He proved the convergence of a scheme for the case of movable ("skew") discontinuities of the heat-conductivity coefficient assuming that $h^2/\tau \to 0$ as $h \to 0$ and $\tau \to 0$. In the present work this requirement is waived for the linear heat-conductivity equation. The authors introduce the original family of homogeneous difference schemes $\rho_{h\tau}^{(\alpha)}$ and formulate the mixed finite-difference problem. With the aid of a-priori estimates and the principle of maximum, the stability of the schemes as a function of the initial conditions and of the right-hand member is then studied. The case of the symmetric six-point scheme

$$\begin{pmatrix} * & * & * & \vline & 0.5 \\ * & * & * & \vline & 0.5 \end{pmatrix} \quad (\alpha = 0.5)$$

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On the convergence of homogeneous...

is of special interest. For it the stability in the mean value under the initial conditions

$$\|z\|_2 \leq M \|z^0\|_2$$

and the stability as a function of the right-hand member Ψ:

$$\|z\|_2 \leq M \|\Psi\|_2$$

is proved. These estimates hold for the case when the lines of discontinuity of the coefficients are the straight lines x = const, and the coefficient of heat conductivity k(x,t) and the thermal capacity c(x,t) satisfy the Lipshits condition with respect to t. For the case of a skew discontinuity an a-priori estimate according to the norm of $(z^{2^n}, 1)^{1/2^n}$, where n = 1, 2, 3, ... The authors conclude by giving the convergence proof for schemes of the family under consideration in the class of discontinuous coefficients, as well as the estimates for the rate of convergence (order of precision) with respect to h and τ. It is proved that the scheme $\varphi^{(\alpha)}_{h\tau}$ with master functionals

$$A[\psi(s)] = \left[\int_{-1}^{0} \frac{ds}{\psi(s)}\right]^{-1}, \quad D[\psi(s)] = F[\psi(s)] = R[\psi(s)] = \int_{-0.5}^{0.5} \psi(s)ds \qquad (\Lambda)$$

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has greater precision than other schemes of the family under consideration. There are 16 references: 11 Soviet-bloc and 5 non-Soviet-bloc. The references to the 4 most recent English-language publications read as follows: M. Lees. Approximate solutions of parabolic equations. J. Soc. Industr. Appl. Math., 1959, 7, no. 2, 167 - 183; M. Lees. Apriori estimates for the solutions of difference approximations to parabolic partial differential equations. Duke Math. J., 1960, 27, no. 3, 297 - 311; M. Lees. Energy inequalities for the solution of differential equations. Trans. Amer. Math. Soc., 1960, 94, 58 - 73; H. Keller. The numerical solution of parabolic partial differential equations. Math. methods digital computers. N. Y. - London, 1960, 135 - 143.

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SUBMITTED: May 14, 1961

31107 S/208/61/001/006/003/013
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16.3900 16.6500 16.3500

AUTHOR: Samarskiy, A. A. (Moscow)

TITLE: Apriori estimations for difference equations

PERIODICAL: Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki, v. 1, no. 6, 1961, 972-1000

TEXT: The author considers difference equations which correspond to differential equations of the following (parabolic and hyperbolic) types:

$$\mathcal{L}_1 u = \frac{\partial}{\partial x}\left[k(x,t,u)\frac{\partial u}{\partial x}\right] - f\left(x,t,u,\frac{\partial u}{\partial x},\frac{\partial u}{\partial t}\right) = 0, \tag{1}$$

$$\mathcal{L}_2 u = \frac{\partial}{\partial x}\left[k(x,t)\frac{\partial u}{\partial x}\right] - c(x,t)\frac{\partial^2 u}{\partial t^2} - f\left(x,t,u,\frac{\partial u}{\partial x},\frac{\partial u}{\partial t}\right) = 0, \tag{2}$$

$$\mathcal{L}_3 u = \frac{\partial^2}{\partial x^2}\left[k(x,t)\frac{\partial^2 u}{\partial x^2}\right] + c(x,t)\frac{\partial^2 u}{\partial t^2} + f\left(x,t,u,\frac{\partial u}{\partial x},\frac{\partial^2 u}{\partial x^2},\frac{\partial u}{\partial t}\right) = 0 \tag{3}$$

The coefficients k(x,t,u) and k(x,t) are assumed to be discontinuous functions. For several cases, the error z = y - u, where y is the solution of the corresponding difference equation, is estimated a priori. This

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paper is a continuation of two earlier papers (A. N. Tikhonov, A. A. Samarskiy. Odnorodnyye raznostnyye skhemy. Zh. vychesl. matem. i matem. fiz., 1961, 1, No. 1, 4-63., A. A. Samarskiy. Apriornyye otsenki dlya resheniya raznostnogo analoga differentsial'nogo uravneniya parabolicheskogo tipa. Zh. vychisl. matem. i matem. fiz., 1961, 1, No. 3, 441-460.). A. N. Tikhonov is thanked for revision of the results of this paper. Bunyakovskiy is mentioned. There are 13 references: 9 Soviet and 4 non-Soviet. The three references to English-language publications read as follows: M. Lees. Approximate solutions of parabolic equations. J. Soc. Industr. and Appl. Math., 1959, 7, No. 2, 167-183; M. Lees, Apriori estimates for the solutions of difference approximations to parabolic equations. Duke Math. J., 1960, 27, 297-311; M. Lees, Energy inequalities for the solutions of differential equations. Trans. Amer. Math. Soc., 1960, 94, 58-73.

SUBMITTED: June 24, 1961

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NIKIFOROV, A.F.; UVAROV, V.B.; LEVITAN, Yu.L.; SAMARSKIY, A.A., prof., otv. red.; ORLOVA, I.A., red.; POPOVA, N.S., tekhn. red.

[Tables of Racah coefficients] Tablitsy koeffitsientov Raka. Moskva, Vychislitel'nyy tsentr AN SSSR, 1962. 319 p. (Quantum theory) (MIRA 15:5)

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16.3500

AUTHOR: Samarskiy, A.A. (Moscow)

TITLE: Homogeneous difference schemes for non-linear parabolic equations

PERIODICAL: Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki, v. 2, no. 1, 1962, 25 - 56

TEXT: Homogeneous difference schemes are considered for the non-linear parabolic equation

$$\mathcal{P} u = \frac{\partial}{\partial x} (k(x, t) \frac{\partial u}{\partial x}) + f(x, t, u, \frac{\partial u}{\partial x}, \frac{\partial u}{\partial t}) = 0 \qquad (1)$$

with discontinuous "heat-conductivity coefficient" $k(x, t)$. The main emphasis is placed on ascertaining the order of accuracy of the six-point scheme $\mathcal{P}^{\alpha}_{h\tau}$ for the third boundary value problem in the bounded domain $\overline{D}$. Various homogeneous difference schemes are simultaneously considered; these are given by means of functionals which ensure the second-order of approximation of the scheme. Dif-

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ference boundary-conditions of the 3rd kind are formulated which have -- in the class of solutions of the equation $\mathcal{P} u = 0$ -- the same order of approximation as the scheme. The accuracy estimate of the obtained difference problem reduces to estimating the solution z of a linear difference equation with linear difference boundary-conditions and zero initial conditions. So-called "fixed discontinuities" of the coefficient $k(x, t)$ are considered, i.e. discontinuities on a finite number of straight lines $x = \eta_\nu = \text{const.}$, parallel to the t-axis in the (x, t)-plane. It is shown that the third boundary-value problem has the same order of accuracy as the first boundary-value problem. The main result is formulated as a theorem on the uniform convergence of the solution of the difference problem. The method used is similar to that cited by M. Lees (Ref. 10: Approximate solutions of parabolic equations. J. Soc. Industr. and Appl. Math., 1959, 7, no. 2, 167 - 183). The results of Ref. 10 (Op.cit.) follow from Theorem 3 of the present article. The apriori estimates used in Ref. 10 (Op.cit.) are however unsuitable for a convergence proof with discontinuous coefficients. Par. 1. Homogeneous difference schemes for nonlinear parabolic equations: The

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problem is formulated as follows: To find a continuous solution $u(x, t)$ of Eq. (1) in the rectangular domain $\overline{D}$ $(0 \leqslant x \leqslant 1,\ 0 \leqslant t \leqslant T)$, which satisfies the boundary conditions

$$k \frac{\partial u}{\partial x} - \sigma_1(t)u = u_1(t), \quad x = 0 \tag{2}$$

$$k \frac{\partial u}{\partial x} + \sigma_2(t)u = u_2(t), \quad x = 1 \tag{3}$$

and the initial condition

$$u(x, 0) = u_0(x). \tag{4}$$

The coefficients $k(x, t)$ has discontinuities of the first kind on the curves Γ_ν $(\nu = 1, 2, \ldots, \nu_0)$. For convenience, Eq. (1) is replaced by equation

$$\mathcal{P} u = \frac{\partial}{\partial x} \left(k(x, t) \frac{\partial u}{\partial x}\right) + f\left(x, t, u, 2k \frac{\partial u}{\partial x}, \frac{\partial u}{\partial t}\right) = 0, \tag{1'}$$

which is considered in the following. The problem defined by Eq. (1') and related conditions, is called Problem I. The difference

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equations corresponding to differential equation (1) is obtained by means of the integro-differential method. Let $\Omega(x_i = ih,\ t_j = j\tau,$ $i = 0, 1, \ldots, N,\ j = 0, 1, \ldots, L,\ h = 1/N,\ \tau = T/L)$ denote the mesh, y -- the mesh function. The sixpoint homogeneous difference equation

$$\mathcal{P}^{\alpha}_{h\tau} y = (a y_{\bar{x}})^{(\alpha)}_{x} + \alpha\varphi(x, t, y, a^{(+1)} y_x + a y_{\bar{x}}, y_{\bar{t}}) + \\ + (1-\alpha)\varphi(x, \check{t}, \check{y}, \check{a}^{(+1)}\check{y}_x + \check{a}\check{y}_{\bar{x}}, y_{\bar{t}}) = 0, \qquad (25)$$

is considered, corresponding to Eq. (1'); α $(0 \leq \alpha \leq 1)$ is a numerical parameter. The mesh functions a and φ are computed by means of the standard functionals

$$A^h[\mu(s)] \quad (-1 \leq s \leq 0) \quad \text{and} \quad F^h[\mu(s)] \quad (-0.5 \leq s \leq 0.5), \qquad (26)$$

viz. $a = A^h[k(x + sh, t)]$, $\varphi = \varphi(x, t, y, a^{(+1)}y_x + a y_{\bar{x}}, y_{\bar{t}}) =$

$$= F^h[f(x + sh, t, y, a^{(+1)}y_x + a y_{\bar{x}}, y_{\bar{t}})].$$

The functionals A^h and F^h satisfy certain conditions (denoted by Φ) As the original difference system one takes Eq. (25) satisfying conditions (Φ). It is shown that the error z = y - u (where y is the solution of the difference equation and u - of the differential equation) satisfies a linear difference equation. Thereby the mesh function Ψ is obtained, representing the approximation error. Par. 2. The difference boundary-value problem: The magnitude of the error z in solving the first difference boundary-value problem depends on the approximation error Ψ only. The boundary conditions of the 3rd kind cannot be exactly satisfied on the difference scheme. Therefore the function z will also depend on the error introduced in approximating the boundary conditions by the difference conditions. The 3rd boundary-value problem for Eq. (1) is

$$\mathcal{P}u = (ku')' + f(x, t, u, 2ku', \dot{u}) = 0, \qquad (5)$$

$$l^{(1)}u = ku' - \sigma_1(t)\,u = u_1(t), \qquad x = 0, \qquad (6)$$

$$l^{(2)}u = ku' + \sigma_2(t)\,u = u_2(t), \qquad x = 1 \qquad (7)$$

where $u' = \partial u/\partial x$, $\dot{u} = \partial u/\partial t$). The difference boundary-conditions

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are $$l_h^{(1)}y = (a^{(+1)}y_x - \sigma_1 y)^{(\alpha)} + 0.5h\,[\alpha f(0, t, y, 2ky_x, y_{\bar{t}}) + (1-\alpha) f(0, \check{t}, \check{y}, 2\check{k}\check{y}_x, y_{\bar{t}})] = u_1^{(\alpha)}(t) \text{ for } x = 0, \quad (8)$$

where $\check{t} = t - \tau$. Formulas are derived for the approximation errors ν_1 and ν_2, of the boundary conditions. The following difference-boundary-value problem is formulated, (corresponding to problem (I)): Find the function $y = y(x, t)$, defined on the mesh $\bar{\Omega}$ and satisfying the difference equation

$$\mathcal{P}_{h\tau}^{\alpha} y = (ay_{\bar{x}})_x^{(\alpha)} + \alpha\varphi(x, t, y, a^{(+1)}y_x + ay_{\bar{x}}, y_{\bar{t}}) + (1-\alpha)\varphi(x, \check{t}, \check{y}, \check{a}^{(+1)}\check{y}_x + \check{a}\check{y}_{\bar{x}}, y_{\bar{t}}) = 0 \text{ on } \Omega, \quad (26)$$

the boundary conditions

$$l_h^{(1)}y = u_1^{(\alpha)}(t), \quad x = 0 \quad (8)$$

$$l_h^{(2)}y = u_2^{(\alpha)}(t), \quad x = 1 \quad (9)$$

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and the initial condition

$$y(x,\ 0) = u_0(x); \tag{27}$$

this problem is called Problem (II). In order to estimate the convergence and accuracy of the solution y(x, t) of Problem (II) with respect to the solution u = u(x, t) of Problem (I), it is necessary to estimate the mesh function z = y - u in terms of the approximation errors , $_1$ and $_2$. From the foregoing follows that z(x, t) is the solution to the following difference boundary-value problem:

$$(az_{\bar{x}})_x^{(\alpha)} + Q(z) - \rho z_{\bar{t}} = -\Psi, \tag{30}$$

$$l_1 z = (a^{(+1)} z_x - \sigma_1 z)^{(\alpha)} + hq_1(z) - \mathscr{E}_1 z_{\bar{t}} = \nu_1, \qquad x = 0, \tag{31}$$

$$l_2 z = (az_{\bar{x}} + \sigma_2 z)^{(\alpha)} - hq_2(z) + \mathscr{E}_2 z_{\bar{t}} = -\nu_2, \qquad x = 1, \tag{32}$$

$$z(x,\ 0) = 0, \tag{33}$$

where Q, q_1 and q_2 are given by formulas

$$Q(z) = b_{11} z_x + b_{12} z_x + b_{22} z_{\bar{x}} + b_{21} z_{\bar{x}} + d_1 z + d_2 z \tag{34}$$

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$$\left.\begin{aligned} q_1(z) &= (\zeta_{11}z + \zeta_{12}\check{z} + \lambda_{11}z_x + \lambda_{12}\check{z}_x)|_{x=0}, \\ q_2(z) &= (\zeta_{22}z + \zeta_{21}\check{z} + \lambda_{22}z_{\bar{x}} + \lambda_{21}\check{z}_{\bar{x}})|_{x=1}. \end{aligned}\right\} \tag{35}$$

$$\left.\begin{array}{llll} 0 < m \leqslant \rho \leqslant M, & 0 < m \leqslant a \leqslant M, & |b_{sk}| \leqslant M, & |d_s| \leqslant M, \\ \mathscr{E}_s \geqslant mh > 0, & \sigma_s \geqslant 0, & \sigma_1 + \sigma_2 \geqslant m > 0, & |\zeta_{sk}| \leqslant M, \\ & |\lambda_{sk}| \leqslant M & (s, k = 1, 2). & \end{array}\right\} \tag{36}$$

Problem (30)-(36) is called Problem (III). Further, numerical methods of solution to Problem (II.) are set forth. Par. 3. On the accuracy of continued-calculation schemes: Estimates are obtained of the solution to Problems (II) and (III). These estimates are derived in the form of theorems and lemmas. Theorem 1: If the conditions

o M, $/o_{\bar{t}}/$ M, o_s M, $/(o_s)_{\bar{t}}/$ M, s = 1, 2, 0.5 α 1 (1, 2)

are satisfied, then (with sufficiently small τ τ_o) the solution to problem (III) is expressed by

$$\|z(x, t)\|_0 \leqslant \left[\sum_{t'=\tau}^{t'=t} \tau \|z_{\bar{t}}(x, t')\|_2^2\right]^{1/2} + \bar{M}(\|z(x, t)\|_2 + \|z_{\bar{x}}(x, t)\|_2) \leqslant \tag{3}$$

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$$\leqslant M\left\{\| z(x,0)\|_{2} + \| z_{\bar{x}}(x,0)\|_{2} + \left[\sum_{t'=\tau}^{t'=t} \tau \| \Psi(x,t')\|_{2}^{2}\right]^{1/2}\right\}, \tag{3}$$

where M and $\tilde{M}$ are positive constants. On the basis of 2 additional conditions

$$\Psi = \bar{\psi}^{(a)}, \quad \nu_1 = \bar{\nu}_1^{(a)}, \quad \nu_2 = \bar{\nu}_2^{(a)}, \tag{9}$$

and

$$\rho \leqslant M, \quad \mathscr{E}_1 \leqslant M, \quad \mathscr{E}_2 \leqslant M \tag{10}$$

(adopted from the references), one obtains Theorem 2: If conditions (1), (2), (9) and (10) are satisfied, one obtains for the solution of Problem (III) the apriori estimate

$$\| z(x,t)\|_{0} \leqslant M\left\{\| \bar{\psi}(x,0)\|_{0} + \| \bar{\psi}(x,t)\|_{0^*} + \left[\sum_{t'=\tau}^{t'=t} \tau\left(\| \bar{\psi}(x,t')\|_{0^*} + \| \bar{\psi}_{\bar{t}}(x,t')\|_{0^*}\right)^2\right]^{1/2}\right\} + \overline{M}\left[\sum_{t'=\tau}^{t'=t} \tau \| \bar{\psi}(x,t')\|_{0}^{2}\right]^{1/2}, \tag{12}$$

where $\overline{M} = 0$ for $b_{11} = b_{12} = b_{22} = b_{21} = 0$. The solution of Problem (III) can be expressed as the sum of 2 particular solutions $z = z_1 + z_2$, where z_1 denotes the solution of the problem with homogeneous

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boundary-conditions ($\nu_1 \equiv 0$, $\nu_2 \equiv 0$), and z_2 - the solution with a homogeneous equation ($\Psi = 0$). Lemma 4: For the error in the solution to Problem (II), due to the error in approximating the boundary conditions, one obtains the estimate

$$//z_2(x, t)//_0 \leqslant M(h^2 + \tau^{m_\alpha}), \text{ if } 0.5 \leqslant \alpha \leqslant 1. \qquad (18)$$

In the case of continuous coefficients k and f, one obtains

$$\Psi = O(h^2) + O(\tau^{m_\alpha}) \text{ at all the points of } \Omega. \qquad (20)$$

Theorem 3: The solution to Problem (II) converges uniformly to the solution u(x, t) of Problem (I), when h and τ tend to zero independently, so that for $\tau < \tau_0$, the inequality

$$//y - u//_0 \leqslant M(h^2 + \tau^{m_\alpha}) \text{ for } 0.5 \leqslant \alpha \leqslant 1 \qquad (21)$$

holds if condition (20) is satisfied. Further, the approximation error in the neighborhood of the line of discontinuity is estimated.

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with coefficients k and f which are discontinuous, one obtains Theorem 4: If k and f have discontinuities of the 1st kind on a finite number of straight lines $x = \eta_\nu$ = const., and the (above-) indicated conditions are satisfied, then the solution y(x, t) of problem (II) converges uniformly to the solution u(x, t) of problem (I) when h and τ tend independently to zero, so that for any mesh system $\mathfrak{P}^{\alpha}_{h\tau}$ of the original difference equations, the estimate

$$//y - u//_0 \leqslant M(h^{1/2} + \tau^{m_\alpha}) \text{ for } 0.5 \leqslant \alpha \leqslant 1 \qquad (50)$$

holds, (with sufficiently small $\tau < \tau_0$). The author expresses his thanks to A.N. Tikhonov. There are 19 references: 14 Soviet-bloc and 5 non-Soviet-bloc. The 4 most recent references to the English-language publications read as follows: J. Douglas, On the numerical integration of quasi-linear parabolic differential equations. Pacif. J.Math., 1956, 6, no.1, 35-42; J. Douglas, The application of stability in the numerical solution of quasilinear parabolic differential equations. Trans. Amer. Math. Soc., 1958, 89, no.2, 484-518; M. Rose, On the integration of non-linear parabolic equations by

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S/208/62/002/001/003/016
D 299/D303

Homogeneous difference schemes for ...

implicit difference methods, Quart. Appl. Math., 1956, 14, no.3, 237-248; M. Lees, Approximate solutions of parabolic equations. J. Soc. Industr. and Appl. Math., 1959, 7, no.2, 167-183.

SUBMITTED: September 30, 1961

X

Card 12/12

SAMARSKIY, A.A. (Moskva)

Convergence and accuracy of homogeneous difference schemes for one-dimensional and multidimensional parabolic equations. Zhur. vych.mat.i mat.fiz. 2 no.4:603-634 Jl-Ag '62. (MIRA 15:8)
(Differential equations)

SAMARSKIY, A. A. (Moskva)

A time-saving difference method of solution of n-dimensional parabolic equations in an arbitrary region. Zhur. vych. mat. i mat. fiz. 2 no.5:787-811 S-O '62.
(MIRA 16:1)

(Differential equations)

TIKHONOV, A. N. (Moskva); SAMARSKIY, A. A. (Moskva)

Homogeneous difference systems on nonuniform nets. Zhur. vych. mat. i mat. fiz. 2 no.5:812-832 S-O '62. (MIRA 16:1)

(Difference equations)

16.3900

S/208/62/002/006/007/007
B112/B186

AUTHOR: Samarskiy, A. A. (Moscow)

TITLE: Convergence of the method of fractional steps for the heat conduction equation

PERIODICAL: Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki, v. 2, no. 6, 1962, 1117-1121

TEXT: The problem

$$\frac{\partial u}{\partial t}=\sum_{\alpha=1}^{2}L_\alpha u,\quad L_\alpha u=\frac{\partial}{\partial x_\alpha}\left(k_\alpha(x,t)\frac{\partial u}{\partial x_\alpha}\right),\quad (x,t)\in Q_T=G x(0<t\leqslant T),\ (1)$$

$$u|_\Gamma=u_1(x,t),\quad t\in[0,T];\quad u(x,0)=u_0(x),\quad x\in\bar{G},\qquad (2)$$

$$k_\alpha(x,t)\geqslant c_1>0\quad (c_1=\text{const}),\quad \alpha=1,2.\qquad (3)$$

is considered under certain genuine conditions. The domain under consideration is covered by a non-uniform rectangular spatial net $\bar{\omega}_h$

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B112/B186

and by a temporal net $\bar{\omega}_\tau$ with integral and fractional steps. For this net a certain locally one-dimensional difference scheme is constructed. It is proved that this scheme converges in the mean with the rate $O(h^2) + O(\tau)$. The investigations concern very general classes of domains, nets, and difference schemes. The method applied has been elaborated in a previous paper of the author (Zh. vychisl. matem. i matem. fiz., 1962, 2, No. 5, 787-811).

SUBMITTED: June 9, 1962

Card 2/2

S/208/63/003/001/004/013
B112/B102

AUTHORS: Tikhonov, A. N., Samarskiy, A. A. (Moscow)

TITLE: Homogeneous difference schemes with a high degree of accuracy over non-uniform nets

PERIODICAL: Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki, v. 3, no. 1, 1963, 99-108

TEXT: This paper is a continuation of previous papers (Zh. vychisl. matem. i matem. fiz., 1961, 1, No 1, 5-64; and No. 3, 425-440), the fundamental estimates of which are shown to be valid without the additional conditions

$$0 < M_1 \leqslant h_{i+1}/h_i \leqslant M_2, \qquad \|h\|_0 \leqslant h_0. \tag{2}$$

The accuracy of zero-rank schemes is characterized by the mean square step

$$\|h\|_2 = (1, h^2)^{1/2} = \Big(\sum_{i=1}^{N} h_i^2 h_i\Big)^{1/2}.$$

It amounts to $O(\|h\|_2^2)$. The results of another paper by the same authors

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Homogeneous difference schemes with ... B112/B102

(Zh. vychisl. matem. i matem. fiz., 1962, 2, No. 5, 812-832) concerning the accuracy of standard schemes over non-uniform nets are improved.

SUBMITTED: September 29, 1962

Card 2/2

L 12744-63 BDS/EWT(d)/FCC(w) AFFTC S/208/63/003/002/005/014 51
IJP(C)

AUTHOR: Samarskiy, A. A. (Moscow)

TITLE: Schemes of uniform differences over uneven lattices for parabolic-type equations 16

PERIODICAL: Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki, v. 3, no. 2, 1963, 266-298

TEXT: In previous papers (Ref. 1-5: Zh. vychisl. matem. i matem. fiz., 1961, 1, No. 3, 441-460; 1961, 1, No. 5, 806-824; 1961, 1 No. 6, 979-1000; 1962, 2, No. 1, 25-56; 1962, 2, No. 4, 603-634) the author investigated the basic problems of the theory of uniform differences of lattices for linear, quasi-linear, and non-linear parabolic-type equations and established the stability, convergence, and estimates of the rate of convergence of certain families of uniform differences within the class of continuous and discontinuous coefficients of differential equations. A. N. Tikhonov and A. A. Samarskiy (Ref. 6: Zh. vychisl. matem. i matem. fiz., 1962, 2, No. 5, 812-832) pointed out that schemes of differences having a second order of approximation over an even lattice have only a first order of approximation over uneven lattices indicating that the accuracy problem for uneven lattices requires further studies. The present paper studies schemes of uniform

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differences for parabolic-type equations with one spacial variable and begins the study of a new family of schemes of uniform differences for the equation

$$L^{(k,q,f)}u = \frac{d}{dx}\left(k(x)\frac{du}{dx}\right) - q(x)u + f(x) = 0 \qquad (1.B)$$

which over special k, q, and f-dependent sequences of lattices $\omega_h(k)$ have for the class of discontinuous coefficients a second degree of accuracy. The studies of the errors, discontinuous coefficients, and order of magnitudes over uneven lattices are followed by the investigation of uniform schemes of differences for the linear and quasi-linear equations

$$c(x,t)\frac{\partial u}{\partial t} = \frac{\partial}{\partial x}\left(k(x,t)\frac{\partial u}{\partial x}\right) + r(x,t)\frac{\partial u}{\partial x} - q(x,t)\,u + f(x,t) \qquad (2.B)$$

$$c(x,t)\frac{\partial u}{\partial t} = \frac{\partial}{\partial x}\left(k(x,t,u)\frac{\partial u}{\partial x}\right) + f\left(x, t, u, \frac{\partial u}{\partial x}\right) \qquad (3.B)$$

and the author calculates their respective errors of approximation over uneven

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lattices. Next he develops the à priori estimates and uses them for the discussion of stabilities and related topics, and also for the proof of theorems concerning the order of accuracy of uniform schemes of differences for (2.B) and (3.B) on a sequence of uneven lattices. The conclusion is that the order of accuracy of these schemes remains unchanged during the transition to uneven lattices.

SUBMITTED: December 12, 1962

Card 3/3

L 10802-63 EWT(d)/FCC(w)/BDS--AFFTC--IJP(C)

ACCESSION NR: AP3001099 S/0208/63/003/003/0431/0466

51

AUTHOR: Samarskiy, A. A. (Moscow)

TITLE: Locally one-dimensional difference schemes on nonuniform nets 16

SOURCE: Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki, v. 3, no. 3, 1963, 431-466

TOPIC TAGS: parabolic-type differential equation, difference scheme

ABSTRACT: Difference schemes for the solution of p-dimensional parabolic-type equations

$$c(x,t)\frac{\partial u}{\partial t} = \sum_{\alpha=1}^{p} L_\alpha u + f,$$

where $x = (x_1, \ldots, x_p)$ is the point of p-dimensional Euclidean space, L_α is a differential operator, and $c(x,t)$ and f are certain functions, are studies for four particular types of the differential operator L_α and the function f.

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Depending on the form of L_α and f, four problems I_k (k = 0, 1, 3) are defined for the solution of which the construction of locally one-dimensional difference schemes II_k (k = 1, 2, 3, 1', 2') using nonuniform nets is presented. Determination of the approximation error z(x,t)-y(x,t), where u(x,t) is the solution of the problem I_k and y(x,t) is the solution of the corresponding difference problem II_k characterizing the correctness of the schemes, is analyzed. Great attention is paid to the a priori estimates (mean estimates and uniform estimates) of the correctness of schemes II_k. To obtain such estimates the method of energetic inequalities of nth rank developed earlier by the author is used. The a priori estimates derived make it possible to prove the convergence of locally one-dimensional schemes when the coefficients of the differential equation have discontinuities of the first kind on a finite number of hyperplanes parallel to coordinate hyperplanes. It is noted that by selecting proper nets, second-order accuracy with respect to h (h is a mesh size) can be achieved for the difference schemes presented. Orig. art. has: 168 equations.

ASSOCIATION: none

SUBMITTED: 26Jan63 DATE ACQ: 10Jun63 ENCL: 00

SUB CODE: MM NO REF SOV: 019 OTHER: 003

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Card 2/2

L 19493-63 EPF(c)/EWT(1)/EPF(n)-2/BDS AFFTC/ASD/IJP(C)/SSD Pr-
ACCESSION NR: AP3004958 S/0208/63/003/004/0702/0719

AUTHORS: Samarskiy, A. A.; Sobol', I. M. (Moscow)

TITLE: Examples of numerical computation of temperature waves

SOURCE: Zhurnal vy*chisl. matematiki i matematich. fiziki, v. 3, no. 4, 1963, 702-719

TOPIC TAGS: differential equation, heat equation, generalized solution, approximate solution

ABSTRACT: This paper is concerned with numerical solution of a quasilinear equation of heat conductivity

$$\frac{\partial u}{\partial t} = \sum_{\alpha=1}^{p} \frac{\partial}{\partial x_\alpha}\left(K_\alpha(u)\frac{\partial u}{\partial x_\alpha}\right) \qquad (1)$$

for the cases p = 1,2,3. As usual it is always assumed that

$$K_\alpha(u) = \varkappa_\alpha u^{\sigma_\alpha}, \qquad (2)$$

where $\sigma_\alpha \geq 1$, $\varkappa_\alpha > 0$. Although (1) arises in various areas of mathematical physics,

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the authors, for definiteness, call the function $u = u(t, x_1, \ldots, x_p)$ a temperature function. Ya. B. Zel'dovich and A. S. Kompaneyets (K teorii rasprostraneniya tepla pri teploprovodnosti, zavisyashchey ot temperatury*. V "Sb. k semidesyatiletiyu akademika A. F. Ioffe". M., Izd-vo AN SSSR, 1950, 61-71.) and G. I. Barenblatt (O nekotory*kh neustanovivshikhsya dvizheniyakh zhidkosti i gaza v poristoy srede. Prikl. matem. i mekhan., 1952, 16, No. 1, 67-78.) have shown that equation (1), in case $p = 1$, has a solution whose derivatives, at the points where $u(t,x)$ goes to zero, are discontinuous and the flow $K(u)\,\partial u/\partial x$ is continuous, i.e. there exists a temperature front $u = 0$ which is propagated with finite velocity. In this case the equation has no classical solution. The existence of a generalized solution of the Cauchy problem and boundary value problems are proven by O. A. Oleynik, A. S. Kalashnikov and Chou Yu-lin (Uravneniya tipa nestatsionarnoy fil'tratsii. Izv. AN SSSR, 1958, 22, No. 5, 667-704.) and others proved convergence of an explicit difference scheme for an equation of the form

$$\frac{\partial u}{\partial t} = \frac{\partial^2 F(u)}{\partial x^2} \qquad (3)$$

in the class of generalized solutions (these results can probably be extended to the case of implicit schemes). M. A. Tairov (Resheniye odnoy zadachi nestatsionarnoy fil'tratsii metodom integral'ny*kh sootnosheniy. Zh. vy*chisl. matem. i matem. fiz.,

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1962, 2, No. 5, 938-942) computed the generalized solution of an equation of the form (3) by Dorodnitsy*n's method of integral relations. For computation of such generalized solutions (which they call temperature waves or simply solutions) the authors use homogeneous difference schemes of continuous computation not specifying clear separation of points of weak discontinuity. The theory of such schemes has been worked out by various authors. However, all the proofs of convergence assume that $K_\alpha(u) \geq c > 0$ and despite the great generality of these theorems, they are not applicable to the case where $K_\alpha(u)$ goes to zero (even allowing discontinuous functions $K_\alpha = K_\alpha(t,x,u)$). The aim of this article is to show that these schemes are also suitable for computation of temperature waves. Such schemes make it possible to carry out the computation by large steps in time, to give the velocity of propagation of the front well, and, for a sufficiently fine grid, also the profile of the front. In the case of space variables ($p > 1$) the authors use the locally one-dimensional method of variable directions set forth by A. A. Samarskiy (Ob odnom ekonomichnom raznostnom metode resheniya mnogomernogo parabolicheskogo uravneniya v proizvol'noy oblasti. Zh. vy*chisl. matem. i matem. i fiz., 1962, 2, No. 5, 787-811) and (Local'no-odnomerny*ye skhemy* na neravnomernoy setke dlya mnogomerny*kh parabolicheskikh uravneniy. Zh. vy*chisl. matem. i matem. fiz., 1963, 3, No. 3, 431-466). The authors give a brief characterization of the

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method of the last two cited papers which is applicable to equation (1). A step in time $t^j \leq t \leq t^{j+1}$ is divided into p layers of identical thickness ("fractional steps")

$$t^{j+(\alpha-1)/p} \leqslant t \leqslant t^{j+\alpha/p}, \quad \alpha = 1, 2, \ldots, p. \qquad (4)$$

In the layer numbered α one solves the one-dimensional equation

$$\frac{1}{p}\frac{\partial u}{\partial t} = \frac{\partial}{\partial x_\alpha}\left(K_\alpha(u)\frac{\partial u}{\partial x_\alpha}\right). \qquad (5)$$

Here, all other coordinates x_β, distinct from x_α, play the role of parameters. At this stage, for boundary conditions the authors use values of the boundary functions at points of intersection of straight lines parallel to the ox_α axis from the boundaries of the region of integration, and for initial values they take values obtained from computation of the preceding layer. Actually, for solution of all the equations (5) they use one and the same one-dimensional program in which (5) is replaced by an implicit homogeneous difference scheme (in section 2, § 2). The authors claim that in their opinion there is no more suitable method at present for

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the solution of multidimensional quasilinear parabolic equations. This method is applicable to arbitrary regions (not only to parallepipeds) and keeps its order of accuracy on inhomogeneous grids. It is suitable for quasilinear parabolic equations of general form even in the presence of coefficients of discontinuities (type I). In such a wide area of usefulness, the method of variable directions has a whole series of merits; simplicity of the program, lowering (in contrast to the majority of other schemes) of the required size of operative memory, stability of computation with very coarse steps in time. It makes it possible, in particular, to solve rapidly complex problems where great accuracy is not required. Computations by any difference scheme give, instead of the exact wave profile, some difference profile (the finer the grid, the greater the accuracy). For studying the construction of this profile with a very coarse grid and estimating the effective width of the front, the authors constructed, in §5, for the case $p = 1$, a difference running wave — an analog to the well known equation of the form $u = f(ct - x)$, called a running wave (the constant c is the velocity of the wave). For difference schemes of continuous computation of gas dynamics with viscosity the difference running wave was constructed by A. A. Samarskiy and V. Ya. Arsenin (O chislennom reshenii uravneniy gazodinamiki s razlichny*mi tipami vyazkosti. Zh. vy*chisl. matem. i matem. fiz., 1961, 1, No. 2, 357-360). It is necessary to stress that the authors never tended to choose the most favorable conditions for computation of a given problem. On the

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contrary, in some cases they knowingly chose bad conditions in order to make the work more remarkable. The grids in the area of some examples are coarse, in others, rather fine. The step in time is always coarse. Orig. art. has: 24 formulas, 8 tables, and 10 figures.

ASSOCIATION: none

SUBMITTED: 06Apr63 DATE ACQ: 30Aug63 ENCL: 00

SUB CODE: MM NO REF SOV: 015 OTHER: 000

Card 6/6

SAMARSKIY, A.A. (Moskva)

High-order correct schemes for the equation of multidimensional heat conduction. Zhur. vych. mat. i mat. fiz. 3 no.5:812-840 S-O '63. (MIRA 16:11)

SAMARSKIY, A.A. (Moskva); ANDREYEV, V.B.

A difference scheme of a higher order of accuracy for an elliptic equation in several space variables. Zhur. vych. mat i mat fiz. 3 no.6:1006-1013 N-D '63. (MIRA 17:1)

S/020/63/149/003/005/028
B112/B180

AUTHORS: Tikhonov, A. N., Corresponding Member AS USSR, Samarskiy, A. A.

TITLE: Stability of difference schemes

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 149, no. 3, 1963, 529 - 531

TEXT: An example is given which shows that the hypothesis that a difference scheme is stable in a class of variable coefficients if it is stable in a class of constant coefficients is not valid when the class of variable coefficients contains only piece-wise continuous and piece-wise differentiable functions.

SUBMITTED: December 29, 1962

Card 1/1

VLADIMIROV, L.A.; SAMARSKIY, A.A.; SHCHELKACHEV, V.N. (Moscow)

"The solution of special boundary value problems of the unsteady motion of an elastic fluid in a elastic layer with the aid of electronic computers"

report presented at the 2nd All-Union Congress on Theoretical and Applied Mechanics, Moscow, 29 January - 5 February 1964

S/0208/64/004/001/0161/0165

ACCESSION NR: AP4012009

AUTHOR: Samarskiy, A. A. (Moscow)

TITLE: Higher order accuracy difference scheme for the heat equation with several space variables

SOURCE: Zhurnal vy*chisl. matem. i matem. fiz., v. 4, no. 1, 1964, 161-165

TOPIC TAGS: difference scheme, heat equation, space variable, parallelepiped, two level scheme, economical scheme, stability, convergence in norm

ABSTRACT: Suppose that in $\bar{Q}_T = \bar{G} \times [0 \leq t \leq T]$, where $\bar{G} = \{0 \leq x_\alpha \leq l_\alpha, \alpha = 1, \ldots, p\}$ there is an r-dimensional parallelepiped with boundary Γ, for the problem

$$\frac{\partial u}{\partial t} = \sum_{\alpha=1}^{p} L_\alpha u + f(x, t), \quad L_\alpha u = \frac{\partial^2 u}{\partial x_\alpha^2}, \tag{1}$$

$$u_\Gamma = \mu(x, t), \quad u(x, 0) = u_0(x), \quad x = (x_1, \ldots, x_p). \tag{2}$$

In a previous paper (Skhemy* povy*shennogo poryadka tochnosti dlya mnogomernogo uravneniya teploprovodnosti. Zh. vy*chisl. matem. i matem. Fiz., 1963, 3, No. 5,

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ACCESSION NR: AP4012009

812-840), for solving problem (1)-(2), the author proposed a two-level economical difference scheme, and, by the method of energy equalities, showed that this scheme is absolutely stable and converges in the norm of $\mathcal{L}_2(\omega_h)$ at the rate $O(h^4 + t^2)$ for $p \leq 3$. In the present paper he shows that this scheme also has these properties for $p = 4$, i.e., it is suitable for $p \leq 4$. Orig. art. has: 36 formulas.

ASSOCIATION: none

SUBMITTED: 15Aug63

DATE ACQ: 14Feb64

ENCL: 00

SUB CODE: MM

NO REF SOV: 001

OTHER: 001

Card 2/2

ACCESSION NR: AP4037265 S/0208/64/004/003/0580/0585

AUTHOR: Samarskiy, A. A.

TITLE: An economic algorithm for the numerical solution of systems of differential and algebraic equations

SOURCE: Zhurnal vy*chislitel'noy matematiki i matematicheskoy fiziki, v. 4, no. 3, 1964, 580-585

TOPIC TAGS: economic difference scheme, differential equation system, algebraic equation system, linear equation system, operator equation system, Cauchy problem, first order differential equation

ABSTRACT: For the solution of systems of first-order ordinary differential equations, an economic (with respect to the number of operations) difference scheme of second-order accuracy is analyzed. The selection of such a scheme is made in connection with the solution of the Cauchy problem

$$\frac{du}{dt} + Au = f(t),\ 0<t\leq T,\ u(0) = u_0,$$

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where $u = u(t)$ and $f(t)$ are n-dimensional vectors and A is an $n \times n$ matrix. With the assumption that the matrix A can be represented as the sum of two triangular positive definite matrices A_1 and A_2, a two-step difference scheme is proposed, which for $n>5$ requires the least number of operations as compared with other schemes. It is proved that under certain conditions this scheme is of second-order accuracy. It is shown that the same difference scheme can be used as an iterative procedure for the solution of the system of n linear algebraic equations

$$Au = A_1 u + A_2 u = f; \; A = a_{ik},$$

where A_1 and A_2 are positive definite triangular matrices. An iterative scheme is presented, and it is proved that this scheme converges at the rate of a certain geometric progression for any positive definite diagonal matrix D when A_1 and A_2 satisfy certain conditions. It is stated that the results obtained are valid for the case when A_1 and A_2 are arbitrary linear operators in Hilbert space H. Orig. art. has: 31 formulas.

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ACCESSION NR: AP4037265

ASSOCIATION: none

SUBMITTED: 09Jan64 DATE ACQ: 09Jun64 ENCL: 00

SUB CODE: MA NO REF SOV: 006 OTHER: 002

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ACCESSION NR: AP4042752 S/0208/64/004/004/0638/0648

AUTHOR: Samarskiy, A. A. (Moscow)

TITLE: Locally one dimensional difference schemes for multidimensional hyperbolic equations in an arbitrary region

SOURCE: Zhurnal vy*chislitel'noy matematiki i matematicheskoy fiziki, v. 4, no. 4, 1964, 638-648

TOPIC TAGS: difference scheme, one dimensional scheme, hyperbolic equation, parabolic equation, nonuniform grid, decomposition scheme

ABSTRACT: In previous work the author established an economical method for solving parabolic equations in several variables. This method is called locally one-dimensional. He now studies locally one-dimensional difference schemes for hyperbolic equations in an arbitrary region G. These schemes converge on arbitrary nonuniform grids ω_h. If the region G is a parallelepiped then many other schemes can be constructed which are decomposition schemes. The author shows the rate of convergence of the solution of the difference scheme to the solution of the differential equation in certain cases. Orig. art. has: 53 formulas.

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ACCESSION NR: AP4042760 S/0208/64/004/004/0753/0759

AUTHOR: Samarskiy, A. A. (Moscow)

TITLE: Economic difference schemes for equations of parabolic type with mixed derivatives

SOURCE: Zhurnal vy*chislitel'noy matematiki i matematicheskoy fiziki, v. 4, no. 4, 1964, 753-759

TOPIC TAGS: difference equation, parabolic equation, operations research, matrix algebra, matrix symmetry, network function

ABSTRACT: The author discussed the problem of solving the system

$$\frac{\partial u}{\partial t}=\sum_{\alpha=1}^{p}\sum_{\beta=1}^{p}\frac{\partial}{\partial x_\alpha}\left(k_{\alpha\beta}(x,t)\frac{\partial u}{\partial x_\beta}\right)+\sum_{\alpha=1}^{p}r_\alpha(x,t)\frac{\partial u}{\partial x_\alpha}+f(x,t,u)=Lu+f; \quad (1)$$

$$u|_{x_\alpha=0}=u_{1\alpha}^{-}(x,t), \qquad u|_{x_\alpha=l_\alpha}=u_{1\alpha}^{+}(x,t), \qquad \alpha=1,\ldots,p; \quad (2)$$

$$u(x,0)=u_0(x), \qquad x=(x_1,\ldots,x_p). \quad (3)$$

with given: p-dimensional parallelepiped $\bar{G}=\{0<x_\alpha<l_\alpha,\ \alpha=1,\ldots,p\}$ and the cylinder $\bar{Q}_T=\bar{G}\times[0<t<T]$. The matrix $(K_{\alpha\beta})$ is defined as

ACCESSION NR: AP4042760

$\sum_{\alpha,\beta=1}^{p} k_{\alpha\beta}(x,t)\,\xi_\alpha\xi_\beta > \gamma \sum_{\alpha=1}^{p} \xi_\alpha^2, \quad (x,t) \in \overline{Q}_T,$ where $\gamma = \text{const} > 0$, $\xi = (\xi_1, \ldots, \xi_\alpha, \ldots, \xi_p)$ any real vector. He introduced the even number rectangular net $\overline{\omega}_h = \{x_i = (x_1^{(i_1)}, \ldots, x_\alpha^{i_\alpha}, \ldots, x_p^{(i_p)}),\ x_\alpha^{i_\alpha} = i_\alpha h_\alpha,\ i_\alpha = 0, 1, \ldots, N_\alpha\}$, $\omega_h = \{x_i \in G,\ i_\alpha = 1, \ldots, N_\alpha - 1,\ \alpha = 1, \ldots, p\}$, the operator $L_{\alpha\beta}u = \frac{\partial}{\partial x_\alpha}\left(k_{\alpha\beta}(x,t)\frac{\partial u}{\partial x_\beta}\right)$ and the approximation $\Lambda_{\alpha\beta}y = \frac{1}{2}\left[(a_{\alpha\beta}y_{\bar{x}_\beta})_{x_\alpha} + \left(a_{\alpha\beta}^{(+1_\beta)}y_{x_\beta}\right)_{\bar{x}_\alpha}\right],\ \beta \neq \alpha$. Several cases are discussed in regard to their solution algorithm: 1) the case when $(K_{\alpha\beta})$ is a triangular matrix; 2) the case of an arbitrary $(K_{\alpha\beta})$ matrix and the transformation of relationship (1) into triangular form; 3) the case when $(K_{\alpha\beta})$ is symmetric. The questions of stability and convergence in the triangular matrix case are discussed. The author then proposes and proves two lemmas and one theorem which account for other solution algorithms and schemes available under certain boundary conditions and constraints. All schemes discussed follow the principle of constructing economic schemes for $\frac{\partial u}{\partial t} = Lu + f$, $\frac{\partial^2 u}{\partial t^2} = Lu + f$, where $Lu = \sum_\alpha L_\alpha u$, and L_α - linear unbounded operators.

Orig. art. has: 38 equations.

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SAMARSKIY, A.A. (Moskva)

Economical difference schemes for systems of parabolic equations. Zhur. vych. mat. i mat. fiz. 4 no.5:927-930 S-O '64. (MIRA 17:12)

L 18998-65 EWT(d) Pg-4 IJP(c)/ASD(a)-5/AEDCA/ESD(dp) S/0208/64/004/006/1025/1036

ACCESSION NR: AP5001453

AUTHORS: Samarskiy, A. A. (Moscow); Andreyev, V. B. (Moscow)

TITLE: Iteration schemes of variable directions for numerical solution of the Dirichlet problem

SOURCE: Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki, v. 4, no. 6, 1964, 1025-1036

TOPIC TAGS: maximum principle, Dirichlet problem, Poisson equation, approximation calculation

ABSTRACT: The authors prove convergence in mean of fourth-order difference schemes with rate $O(|h|^4)$ where

$$|h|^2 = \sum_{\alpha=1}^{p} h_\alpha^2, \qquad (1)$$

with any ratio h_α between steps. They study such a scheme on a rectangular grid ($h_\alpha \neq h_\beta$ for $\alpha \neq \beta$) for the Poisson equation and in a p-dimensional rectangular parallelepiped ($p = 2,3$) for the Dirichlet problem. Conditions are given under which the maximum principle can be used for these schemes on a rectangular grid,

APPROVED FOR RELEASE: 08/25/2000 CIA-RDP86-00513R001446920010-4"

L 44140-65 EWT(d) ~~Pg-4~~ ~~IJP(c)~~

ACCESSION NR: AT5010204 UR/3043/65/000/003/0147/0162

18
17

AUTHOR: Samarskiy, A. A.; Mostinskaya, S. B.

16 B+1

TITLE: Methods for solving differential equations and adjacent problems

SOURCE: Moscow, Universitet. Vychislitel'nyy tsentr. Sbornik rabot, no. 3, 1965. Vychislitel'nyye metody i programmirovaniye (Computing methods and programming), 147-162

TOPIC TAGS: numerical analysis, heat conduction equation, two dimensional equation, locally one dimensional method

ABSTRACT: This article deals with the numerical solution of the two-dimensional quasilinear heat-conduction equation written in polar coordinates whose coefficients have discontinuities of the first kind and whose boundary conditions are of the third kind. The locally-one-dimensional method developed previously by A. A. Samarskiy (Zhurnal vychislitel'noy metematiki i' matematicheskoy fiziki, v. 2, no. 5, 1962) for the solution of parabolic equations is used to solve this equation. A uniform locally one-dimensional difference scheme is

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ACCESSION NR: AT5010204

constructed in such a way that the discontinuities of the coefficients coincide with the lattice points of the computational net. The construction of the difference scheme is achieved by means of successive solutions of one-dimensional heat-conduction equations obtained by the Seidel iterative method. The convergence of the method is analyzed for uniform and non-uniform nets and the rate of convergence is established. The variation of the accuracy of the method with the variation of the mesh size of the net is analyzed. Numerical solutions of three examples illustrate the applicability of the proposed method. The authors conclude that this method is sufficiently accurate and absolutely stable, each for non-uniform nets. Therefore, this method makes it possible to carry out calculations with sufficiently large time steps and to obtain quick solutions for many physical problems. It is indicated that the method can be realized on high-speed electronic computers. Orig. art. has: 4 figures and 21 formulas. [LK]

ASSOCIATION: Vychislitel'nyy tsentr, Moskovskiy universitet (Computing Center, Moscow University)

SUBMITTED: 00 ENCL: 00 SUB CODE: MA, TD

NO REF SOV: 010 OTHER: 000 ATD PRESS: 3247

Card 2/2

L 63282-65 EWT(d) IJP(c)
ACCESSION NR: AP5014761 UR/0208/65/005/003/0548/0551
518:517.944/.947

AUTHOR: Samarskiy, A. A. (Moscow)

TITLE: On monotonic difference representations for elliptic and parabolic equations in the case of a non-self-conjugate elliptic operator

SOURCE: Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki, v. 5, no. 3, 1965, 548-551

TOPIC TAGS: Laplace transformation, elliptic equation, parabolic equation, approximation method

ABSTRACT: Monotonic representations for a non-self-conjugate elliptic equation of second order in an arbitrary region are developed. The first schemes considered are characterized by a uniform rate of decrease denoted by $O(h^2)$. Additional consideration is given to monotonic, locally one-dimensional schemes which decrease uniformly at a rate $O(h^2 + \tau)$ for a parabolic equation with a non-self-conjugate elliptic operator. The monotonic representations are demonstrated by means of example problems. The first example yields a representation of the first boundary problem in a particular region of a multidimensional space. The problem is defined in terms of its first derivatives, and a monotonic representation is developed to the

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L 63282-65

ACCESSION NR: AP5014761

second order of accuracy. The author proves the validity of the presumed accuracy of the scheme developed. The second example involves a parabolic equation in the cylindrical region $\bar{Q}_T = (G+\Gamma) \times [0 \le t \le T]$. The problem is stated as

$$\frac{\partial u}{\partial t} = Lu + f, \quad u|_\Gamma = v(x, t),$$

$$u(x, 0) = u_0(x),$$

where

$$k_\alpha = k_\alpha(x, t), \quad q = q(x, t), \quad f = f(x, t)$$

and

$$Lu = \sum_{\alpha=1}^{p} L_\alpha u, \quad L_\alpha u = \varkappa_\alpha \frac{\partial}{\partial x_\alpha}\left(k_\alpha(x, t) \frac{\partial u}{\partial x_\alpha}\right) + r_\alpha(x, t) \frac{\partial u}{\partial x_\alpha} - q_\alpha(x, t) u.$$

Additional conditions and definitions are $q_\alpha \ge 0, \sum_{\alpha=1}^{p} q_\alpha = q,$

and

$$\varkappa_\alpha = \left(1 + \sum_{\beta \ne \alpha}^{1-p} R_\beta\right) \Big/ \left(1 + \sum_{\beta=1}^{p} R_\beta\right).$$

The selection of a time interval is discussed, and certain substitutions are made such that the locally one-dimensional scheme is represented in the form

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L 63282-65

ACCESSION NR: AP5014761

$$\frac{y_{(\alpha)}^j - y_{(\alpha-1)}^j}{\tau} = \Lambda_\alpha(t_\alpha^*)y_{(\alpha)}^j + f_\alpha(x, t_\alpha^*), \quad \alpha = 1, 2, \ldots, p, \quad j = 0, 1, \ldots,$$

$$y|_{t=0} = u_0(x).$$

Certain ramifications of the problem due to particular boundary conditions are discussed. Orig. art. has: 11 equations.

ASSOCIATION: none

SUBMITTED: 06Feb65 ENCL: 00 SUB CODE: MA

NO REF SOV: 003 OTHER: 000

Card 3/3

L 324-65 EWT(d)/EWP(w)/EWT(m)/EWA(d) Pg-4 IJP(c) EM
ACCESSION NR: AP5005787 S/0208/65/005/001/0034/0043

16
14
B

AUTHOR: Samarskiy, A. A. (Moscow)

TITLE: Economical difference schemes for systems of hyperbolic equations with mixed partial derivatives and their application to the solution of equations of elasticity theory 26

SOURCE: Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki, v. 5, no. 1, 1965, 34-43

TOPIC TAGS: economical difference scheme, additive difference scheme, hyperbolic equation system, second order hyperbolic system, factorizable operator

ABSTRACT: Economical additive difference schemes for systems of second-order hyperbolic equations containing mixed partial derivatives and their application to the solution of equations of elasticity theory are analyzed. It is shown that such schemes are schemes of alternating directions, they are absolutely stable and convergent with a rate of convergence of the order $O(|h|^2 + \tau)$ where

$$|h|^2 = \sum_{\alpha=1}^{p} h_\alpha^2,$$

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L 27624-65
ACCESSION NR: AP5005787

h is a step of a spatial net, τ is a time step, and p is the number of dimensions. The essential operation of the computation algorithm is the inversion of the three-point-triangular operator which is reduced to the successive application of known formulas of the "drive through" (elimination) method. The number of operations for determining the solution on every time level of the spatial net is proportional to the number of lattice points of the net and is of the same order as the number of operations for a purely explicit scheme. The economical additive difference schemes derived are used for constructing economical schemes for a system of equations of elasticity theory in the cases where p = 2 and p = 3. An economical scheme with a factorizable operator for solving equations of elasticity theory is constructed, which is absolutely stable and converges at a rate on the order of $O(|h|^2 + \tau^2)$. An iteration scheme of alternating directions for solving the stationary problem of elasticity theory is presented. The convergence of this scheme is proved for p = 2 and p = 3 and it is shown that the number of iterations required is equal to

$$\nu = O(h^{-2(p-1)/p} \ln (1/\varepsilon))$$

where ε is the required accuracy. Orig. art. has: 32 formulas. [LK]

ASSOCIATION: none

Card 2/3

L 27624-65

ACCESSION NR: AP5005787

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SUBMITTED: 01Oct64 ENCL: 00 SUB CODE: MA

NO REF SOV: 009 OTHER: 001 ATD PRESS: 3190

Card 3/3

L 57051-65 EPF(n)-2/EPR/EPA(s)-2/EWG(v)/EWT(1)/EWA(1) Pe-5/Ps-4/Pt-7/Pu-4 WW

ACCESSION NR: AP5009387 S/0208/65/005/002/0199/0217 58
517.9:532 52 B

AUTHOR: Samarskiy, A. A. (Moscow); Kurdyumov, S. P. (Moscow); Volosevich, P. P. (Moscow)

TITLE: Traveling waves in a medium with nonlinear heat conductivity 21

SOURCE: Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki, v. 5, no. 2, 1965, 199-217

TOPIC TAGS: hydrodynamics, heat conductivity, numerical method, thermodynamics

ABSTRACT: The study of traveling waves under conditions of nonlinear thermal conductivity is related to the problem of a piston operating under thermal conditions. In the framework of the one-dimensional plane problem for hydrodynamic equations with nonlinear heat conductivity, the piston problem is considered for the case of fixed variation of heat flow and piston velocity such that a traveling wave is formed ahead of the piston. Several types of continuous and discontinuous traveling waves are constructed. Along with metastable waves, a wave is constructed which combines two constant solutions and has a finite transition-zone width. The depen-

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ACCESSION NR: AP5009387 6

dence of this width on the parameters of the problem is established. The problem of the traveling wave is regarded as a model for the analysis of possible solutions and their dependence on the degree of nonlinearity of the heat equation. The field of the integral curves is analyzed in relation to the values of indices of nonlinearity. In a number of cases, analytic solutions are presented. A classification of various types of traveling temperature waves is given. Difference methods are used for the machine solution of a system of partial differential equations for appropriate boundary conditions on the piston, and the results for a number of computer solutions are presented. A comparison of the analytic results with numerical solutions makes it possible to judge the accuracy of the difference methods used and to affirm the existence and stability of the traveling waves constructed. "The authors are grateful to L. N. Busurina and V. P. Krus for programming and performing the computer calculations, and also to L. N. Luk'yanova, A. M. Zakharova, and N. G. Teplova, who participated in the work of doing the calculations and formulating the results. The authors acknowledge the useful discussions offered by B. L. Rozhdestvenskiy." Orig. art. has: 27 formulas, 14 figures.

ASSOCIATION: none

Card 2/3

L 57051-65

ACCESSION NR: AP5009387

SUBMITTED: 08Jun64 ENCL: 00 SUB CODE: OP, DP

NO REF SOV: 006 OTHER: 003

Card 3/3

APPROVED FOR RELEASE: 08/25/2000 CIA-RDP86-00513R001446920010-4"

L 63282-65 EWT(d) IJP(c)
ACCESSION NR: AP5014761 UR/0208/65/005/003/0548/0551
518:517.944/.947

AUTHOR: Samarskiy, A. A. (Moscow)

TITLE: On monotonic difference representations for elliptic and parabolic equations in the case of a non-self-conjugate elliptic operator

SOURCE: Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki, v. 5, no. 3, 1965, 548-551

TOPIC TAGS: Laplace transformation, elliptic equation, parabolic equation, approximation method

ABSTRACT: Monotonic representations for a non-self-conjugate elliptic equation of second order in an arbitrary region are developed. The first schemes considered are characterized by a uniform rate of decrease denoted by $O(h^2)$. Additional consideration is given to monotonic, locally one-dimensional schemes which decrease uniformly at a rate $O(h^2 + \tau)$ for a parabolic equation with a non-self-conjugate elliptic operator. The monotonic representations are demonstrated by means of example problems. The first example yields a representation of the first boundary problem in a particular region of a multidimensional space. The problem is defined in terms of its first derivatives, and a monotonic representation is developed to the

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L 63282-65

ACCESSION NR: AP5014761

second order of accuracy. The author proves the validity of the presumed accuracy of the scheme developed. The second example involves a parabolic equation in the cylindrical region $\bar{Q}_T = (G+\Gamma) \times [0 \leqslant t \leqslant T]$. The problem is stated as

$$\frac{\partial u}{\partial t} = Lu + f, \quad u|_\Gamma = v(x, t),$$

$$u(x, 0) = u_0(x),$$

where

$$k_\alpha = k_\alpha(x, t), \; q = q(x, t), \; f = f(x, t)$$

and

$$Lu = \sum_{\alpha=1}^{p} L_\alpha u, \quad L_\alpha u = \varkappa_\alpha \frac{\partial}{\partial x_\alpha}\left(k_\alpha(x, t)\frac{\partial u}{\partial x_\alpha}\right) + r_\alpha(x, t)\frac{\partial u}{\partial x_\alpha} - q_\alpha(x, t)u.$$

Additional conditions and definitions are $q_\alpha > 0, \sum_{\alpha=1}^{p} q_\alpha = q,$

and

$$\varkappa_\alpha = \left(1 + \sum_{\beta \neq \alpha}^{1-p} R_\beta\right) \Big/ \left(1 + \sum_{\beta=1}^{p} R_\beta\right).$$

The selection of a time interval is discussed, and certain substitutions are made such that the locally one-dimensional scheme is represented in the form

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ACCESSION NR: AP5014761

$$\frac{v_{(\alpha)}^{j} - v_{(\alpha-1)}^{j}}{\tau} = \Lambda_{\alpha}(t_{\alpha}^{*}) v_{(\alpha)}^{j} + f_{\alpha}(x, t_{\alpha}^{*}), \quad \alpha = 1, 2, \ldots, p, \quad j = 0, 1, \ldots;$$

$$v|_{t=0} = u_{0}(x)^{j}.$$

Certain ramifications of the problem due to particular boundary conditions are discussed. Orig. art. has: 11 equations.

ASSOCIATION: none

SUBMITTED: 06Feb65 ENCL: 00 SUB CODE: MA

NO REF SOV: 003 OTHER: 000

Card 3/3

SHCHELKACHEV, V.N.; SAMARSKIY, A.A.; VLADIMIROV, L.A.

Solving special boundary problems of nonsteady fluid flow in an elastic bed using electronic computers. Izv. vys. ucheb. zav.; neft' i gaz 8 no.3:77-80 '65. (MIRA 18:5)

1. Moskovskiy institut neftekhimicheskoy i gazovoy promyshlennosti im. akademika Gubkina i Moskovskiy gosudarstvennyy universitet im. M.V. Lomonosova.

SAMARSKIY, A.A. (Moskva); GULIN, A.V. (Moskva)

Difference schemes on "oblique" nets. Zhur. vych. mat. i mat. fiz. 5 no.4:773-776 Jl-Ag '65. (MIRA 18:8)

L 14593-66 EWT(d) IJP(c)

ACC NR: AP6002413 SOURCE CODE: UR/0020/65/165/005/1007/1010

AUTHOR: Samarskiy, A. A.

20
B

ORG: none

16, 44, 55

TITLE: Theory of difference schemes

SOURCE: AN SSSR. Doklady, v. 165, no. 5, 1965, 1007-1010

TOPIC TAGS: Cauchy problem, Hilbert space, Banach space

ABSTRACT: The abstract Cauchy problem

$$du/dt + A(t)u = f(t), \quad 0 \leqslant t \leqslant T, \quad u(0) = u_0, \quad u_0 \in D(A) \quad (1)$$

in Banach and Hilbert spaces is considered. The approach permits determination of sufficient conditions for correctness of schemes which make use only of operator properties which are simple to verify directly. These include such properties as semi-boundedness from below, etc. The author expresses his gratitude to A. N. Tikhonov for his valuable discussions of the results. This paper was presented by academician M. V. Keldysh on 19 April 1965. Orig. art. has: 10 formulas.

SUB CODE: 12/ SUBM DATE: 30Mar65/ ORIG REF: 005/ OTH REF: 001

FW

Card 1/1 UDC: 518.1

L 16117-66 EWT(d)/EWT(l)/ETC(f)/EPF(n)-2/EWG(m)/ IJP(c) WW

ACC NR: AP5025109 SOURCE CODE: UR/0208/65/005/005/0816/0827

AUTHOR: Samarskiy, A. A. (Moscow); Moiseyenko, B. D. (Moscow)

56
52
B

ORG: none

16, 44, 55

TITLE: An economic scheme of through calculus for multidimensional Stefan problems

SOURCE: Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki, v. 5, no. 5, 1965, 816-827

TOPIC TAGS: differential equation, heat transfer, calculus

ABSTRACT: The authors propose an economic difference scheme of through calculus for the numerical solution of Stefan problems with several spatial variables and several numbers of phases. In the proposed scheme the boundary of phase division was not chosen explicitly and homogenous difference schemes were utilized. The proposed scheme was tested for the case of one and two spatial dimensions. In all cases the method yielded solutions with adequate accuracy. The authors solve the multidimensional quasi-linear equation of heat transfer by employing the locally one-dimensional method. This consists of a step-by-step solution with respect to

Card 1/2 UDC: 518:517.944/.947

2

L 16117-66

ACC NR: AP5025109

21,44,55

4

various spatial variables of the one-dimensional heat transfer equation via unconditionally stable implicit schemes. The authors express their thanks to I. V. Friazinov for advice. Orig. art. has: 3 figures, 20 formulas, and 6 tables.

SUB CODE: 12,20 / SUBM DATE: 26Aug64/ ORIG REF: 007/ OTH REF: 001

Card 2/2

LC

L 17897-66 EWT(d)/T/EWP(1) IJP(c)

ACC NR: AP6009993 SOURCE CODE: /0026/65/010/002/0146/0164

40
B

AUTHOR: Samarskiy, A. A.--Samarskij, A. A. (Professor)

ORG: Department of Computer Mathematics, Faculty of Mechanics and Mathematics, Moscow State University, Moscow (Moskovskiy gosudarstvennyy universitet, kafedra vychislitel'noy matematiki mekhaniko-matematicheskogo fakulteta)

TITLE: Difference schemes for multivariant differential equations of mathematical physics

SOURCE: Aplikace matematiky, v. 10, no. 2, 1965, 146-164

TOPIC TAGS: algorithm, differential equation, computer technology, mathematic physics

ABSTRACT: The article describes difference schemes in connection with the development of algorithms of a universal type for computers, suitable for solving a broad class of problems with the same programs. Orig. art. has: 66 formulas. [JPRS]
16,44,55

SUB CODE: 12, 09 / SUBM DATE: none / OTH REF: 002 / SOV REF: 018

Card 1/1 TS

L 18425-66 EWT(d)/EWT(1)/T/EWP(1) IJP(c) GG

ACC NR: AP6003238 SOURCE CODE: UR/0020/65/165/006/1253/1256

AUTHOR: Samarskiy, A. A.

25
B

ORG: none

TITLE: On the principle of additivity for the structuring of economical difference systems

SOURCE: AN SSSR. Doklady, v. 165, no. 6, 1965, 1253-1256

TOPIC TAGS: Cauchy problem, approximate method, difference system, numerical solution, mathematical model

ABSTRACT: Locally one-dimensional systems of solution of multiple-dimensioned problems of mathematical physics are studied. The method presented is based upon the principle of modeling a multi-dimensioned differential equation with the aid of a system of one-dimensional equations with successive application of simplified difference systems to the solution of each of the one-dimensional equations. The principle is applied by the author to the abstract Cauchy problem expressed as

$$du/dt + A(t)u = f(t), \quad 0 \leqslant t \leqslant T, \quad u(0) = u_0, \quad u_0 \in D(A),$$

where $A(t)$ is a linear unbounded operator in space H, and $u = u(t) \in H$ and

UDC: 518.1

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L 18425-66
ACC NR: AP6003238

$f = f(t) \in H$ are defined on the interval $0 \leq t \leq T$. Of interest is the case where A is the sum of linear operators A_α

$$A(t) = \sum_{\alpha=1}^{m} A_\alpha(t).$$

A total of m one-dimensional problems is used in modeling the multi-dimensional problem. In each interval $[t^j, t^{j+1}]$ the system of differential equations

$$dv_{(\alpha)}/dt + A_\alpha(t)v_{(\alpha)}(t) = f_\alpha(t),$$
$$t \in (t^j, t^{j+1}], \quad j = 0, 1, \ldots; \quad \alpha = 1, 2, \ldots, m$$

is successively solved with initial conditions

$$v_{(\alpha)}(t^j) = v_{(\alpha-1)}(t^{j+1}), \quad \alpha > 1; \quad v_{(1)}(t^j) = v_{(m)}(t^j) = v(t^j);$$
$$j \geqslant 0, \quad v(0) = u_0.$$

Approximate solutions to this system are developed for varying conditions of parameter bounds. Five theorems are developed for several cases, and additonal cases are referred to earlier research. This paper was presented by Academician M. V. Keldysh on 19 April 1965. Orig. art. has: 8 equations.

SUB CODE: 12/ SUBM DATE: 30Mar65/ ORIG REF: 007/ OTH REF: 003

Card 2/2 mc

L 38778-66 EWT(d) IJP(c)

ACC NR: AP6025922 SOURCE CODE: UR/0208/66/006/004/0665/0686

AUTHOR: Samarskiy, A. A. (Moscow)

ORG: none

23
B

16

TITLE: Some problems in the theory of difference schemes

SOURCE: Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki, v. 6, no. 4, 665-686

TOPIC TAGS: numerical analysis, difference ~~scheme~~ method, dirichlet problem, ~~longitudinal transversal scheme, scheme stability, scheme convergence~~ integrodifferential equation

ABSTRACT: The algebraic identity and stability of longitudinal-transversal schemes (special form of locally uniform schemes) are analyzed by means of iterative schemes for solving the stationary equation

$$(A_1 + A_2)v = f, \quad (1)$$

where A_1 and A_2 are linear positive-definite operators in a real Hilbert space. It is shown that longitudinal-transversal schemes are algebraically identical to three simple, locally uniform schemes, and new estimates of the rate of convergence of such schemes are derived. It is shown that in order to decrease the initial error $1/\varepsilon$

Card 1/2 UDC: 518:517.944/.947

L 38778-66

ACC NR: AP6025922

times ($\varepsilon > 0$ is the foreassigned accuracy of the scheme), using the longitudinal-transversal scheme, it is necessary to carry out

$$\nu(\varepsilon) > \ln \frac{1}{\varepsilon} \left[\ln \frac{1+\sqrt{\eta}}{1-\sqrt{\eta}} \right]^{-1} \quad (2)$$

iterations ($\eta = \delta/\Delta$, where δ and Δ are certain positive constants). The derived estimates are applied to the solution of three problems: 1) the difference Dirichlet problem in an arbitrary domain for the self-adjoined elliptic operator with variable coefficients; 2) the Dirichlet problem for the nonself-adjoined elliptic operator with constant coefficients; 3) the integro-differential equation of radiation transfer. The longitudinal-transversal scheme for solving the difference Dirichlet problem in an arbitrary p-dimensional domain applies in the case where the difference Laplace operator is represented as the sum of nonself-adjoined operators. Orig. art. has: 90 formulas. [LK]

SUB CODE: 12/ SUBM DATE: 28Jan66/ ORIG REF: 015/ OTH REF: 006/ ATD PRESS: 5051

Card 2/2

SAMARSKIY, Anatoliy Fedorovich; SINITSA, I.V., redaktor; IL'INSKAYA, G.M., tekhnicheskiy redaktor

[Charging batteries of electric locomotives] Pamiatka dlia zariadchika batarei akkumuliatornykh elektrovozov. Moskva, Ugletekhizdat, 1955. 40 p. (MLRA 8:8)

(Storage batteries) (Mine railroads)

BELYY, V.D.; SAMARSKIY, A.F.; TREYGER, M.B.

Strength of mine hoisting ropes and control of its change during use. Trudy MakNII 9 no.2:349-365 '59. (MIRA 12:8)
(Wire ropes--Testing)

BELYY, V.D.; SAMARSKIY, A.F.

Nature of breaking of mine hoisting cables. Trudy MakNII 12: Vop. gor. elektromekh. no.4:176-183 '61. (MIRA 16:6)

(Wire rope)

BELYY, V.D.; SAMARSKIY, A.F.

Development of technical conditions for closed-type mine hoisting cables. Trudy MakNII 12: Vop. gor. elektromekh. no.4: 184-219 '61. (MIRA 16:6)

(Wire rope—Testing)

BELYY, V.D.; SAMARSKIY, A.F.

Norms and methods of controlling closed-type hoisting cables. Trudy MakNII 14. Vop. gor. elektromekh. no.5:156-166 '62. (MIRA 16:6)
(Wire rope—Testing)

BELYY, V.D.; SAMARSKIY, A.F.

Study of the parameters for the manufacture and working capacity of cables made of trihedral strands. Trudy MakNII 14. Vop. gor. elektromekh. no.5:167-181 '62. (MIRA 16:6)
(Wire rope--Testing)

BELYY, V.D.; SAMARSKIY, A.F.

Development of technical requirements of cores for mine hoisting cables. Trudy MakNII 14. Vop. gor. elektromekh. no.5:182-197 '62. (MIRA 16:6)

(Wire rope--Testing)

SAMARSKIY, A.G.

92-58-3-15/32

AUTHORS: Anisimov, A.F., Engineer and Samarskiy, A.G., Engineer

TITLE: Continuous Control of Neutralization of Crude Stock in Atmospheric-Vacuum Pipe Stills (Nepreryvnyy kontrol' rezhima podshchelachivaniya syr'ya na ustanovkakh AVT)

PERIODICAL: Neftyanik, 1958, Nr 3, pp 15-16 (USSR)

ABSTRACT: To protect the equipment against corrosion the crude stock processed in an atmospheric vacuum pipe still has to be neutralized. The neutralization of crude stock is ordinarily controlled by a laboratory test of the water settled from the wide-fraction in the surge tank. The lack of continuous control over the alkalinity of the water shortens the service life of the processing equipment. Therefore, the special construction bureau for the introduction of automation in refineries has studied this problem at the atmospheric-vacuum pipe still of the new Ufa Refinery and ascertained that the

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pH value of the condensation water settling in the tank of the evaporator is almost always 10, while the pH of water drained off from the surge tank of the atmospheric tower depends on the concentration of the reagent (Fig. 1). As a result of this study, it has been proposed that the pH value be determined in the stream before the stream enters the surge tank. Therefore, samples of the product mixed with the settled water were taken at the lowest point of the stream line section between the condenser-cooler of the atmospheric tower and the surge tank (Fig. 2). The mixture was directed through a 1/2-in. tube to a small settler, where the separation of water from the mixture took place. The settled water was filtered and its pH determined. In the course of this operation, it has been found that the present system of calomel electrodes is inadequate for determining the pH value in a polluted mixture containing petroleum products. Therefore, the calomel electrode design was modified (Fig. 3). As a result, the redesigned electrode can now be used during a much longer period of time, and can be easily dismantled and reassembled. On the whole, the equipment operates satisfactorily and this fact was confirmed in 1957 by the new Ufa Refinery. There is one diagram showing alkali consumption, one drawing showing the continuous determination and recording of the pH value, and one sketch of the redesigned calomel electrode.

ASSOCIATION: Ufimskoye otdeleniye konstruktorskogo byuro po avtomatizatsii (Ufa Section of the Design Bureau for Automation)

AVAILABLE: Library of Congress

SAMARSKIY, A. T.

Thermal treatment of wines by passing air. A. T. Samarskii. *Vinodelie i Vinogradarstvo Moldavii* 1953, No. 1, 41-2; *Referat. Zhur., Khim.* 1954, No. 15000.—To increase the stability and sterility of wine, air atomized by passing it through a diffuser is passed through preheated wine. The app. and conditions of treatment are outlined. After the treatment, the wine is cooled to 14-15° by passing cold water through the coils of the app. Best results were obtained for various wines with the following temps. and duration of treatment: dry table wines 58° for 4 min., white dessert wines 53° and 6 min., strong wines 58° 10 min., off-wines 60-70° 4 min. M. Hosch

SAMARSKIY, A. T.

21899. SAMARSKIY, A. T.

Znacheniye krakhmala v zhizni vinogradnogo rasteniya. Vinodeliye i vinogradarstvo moldavii, 1949, No. 3, s. 30-39

SO: Letopis' Zhurnal'nykh Statey, No. 29, Moskva, 1949.

SAMARSKIY, Aleksandr Trofimovich

KALUGINA, Galina Ivanovna; SAMARSKIY, Aleksandr Trofimovich; RUDNEV, Nikolay Mikhaylovich; GERASIMOV, M.A., spetsredaktor; KRUGLOVA, G.I., red.; CHEBYSHEVA, Ye.A., tekhn.red.

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"The possibility of determining, by means of an instrument called a vertical gradiometer, of the second derivative W_{zz} of the potential of the force of gravity with an accuracy of 10 etvesh sufficient for the survey and compilation of anomalous masses located under the observation points at small depths and producing an effect of several tens of etvesh is presented. For this end we may use a gravimeter with a response up to 0.001 mgal, equipped to record two values of gravity accelerations at the same observation point with two installations of the gravimeter in two positions with a constant elevation difference of one meter. During the short time period necessary for observation the error of computation of zero-point variation of the gravimeter, the temperature variation in the thermostat and the barometric correction will be eliminated.